during the first year, and continued to gain weight; but in the second year she had been attacked with rheumatism, followed by what she called bronchitis. Hæmoptysis to the amount of four ounces came on six months previous to admission. The cough had been worse, and the expectoration largely increased. The appetite was good. The temperature and pulse were about normal. The catamenia were irregular, and leucorrhœa was present. The patient had lost eleven pounds since her discharge. Night-sweats were profuse. On examination, scattered crepitation was heard in the upper right lung; and similar sounds were heard on the left side, but to a less extent than when she was in the hospital before. The same treatment was pursued, and she improved until the beginning of April, gaining four pounds. Shortly after this, the cough increased; the expectoration became more abundant; and, on examination of it, lung-tissue was clearly detected. On May 22nd, the crepitation was very coarse in the right lung, the patient losing weight; and this was noted again on the 29th. On June 12th, these signs had diminished; the cough and expectoration were less; and the patient had regained three pounds and a half. Her weight was 6 st. 6½ lbs.

Here, then, was a chronic bronchitis extending over many years. On this catarrhal pneumonia supervened, the formation of tubercle being masked by the emphysema; and in time lung disintegration and excavation took place, the date of the latter being after her second admission into the hospital.

It is curious to note, in this variety of phthisis, how little the pulse and temperature are affected; and it is by no means rare to find lung-disintegration proceeding rapidly over a limited space without raising either pulse or temperature.

The pathology is tolerably simple, though, curious to state, much opposition was at first raised to the catarrhal origin of phthisis; and even now some eminent authorities are much opposed to this mode of causation. A catarrh creeps down the bronchial mucous membrane, and eventually reaches some of the alveoli. Here rapid proliferation of the epithelium takes place, which is the more irritated and prone to multiply, owing to the inhalation of some of the bronchial secretion. The alveoli become choked and stuffed with epithelium; and the vessels may be emptied through pressure; ulceration may follow, and the whole mass may liquefy, caseate, and be expectorated. More commonly, however, caseation of the epithelium takes place, followed by absorption of the necrobiotic material by the lymphatics. Thus the alveolar wall, with the perivascular lymphatics, becomes involved, and adenoid hyperplasia (*i. e.*, the tubercle) is the result.

In many of the instances under my notice, there have never been physical signs of extensive consolidation during life; but breaking down of the lung has occurred very rapidly, and cavities have formed in one or more portions; and though the physical examination may teach us much, the only way to be sure of ascertaining that this process is going on is to examine the sputum frequently and carefully.

Most cases of catarrhal phthisis gradually become one of chronic tubercular phthisis, and consequently the *post mortem* appearances do not differ materially from those of the latter variety. In early instances, however, as Rindfleisch shows, where only certain lobules are invaded by catarrhal pneumonia, centres of caseation may be traced in the track of these lobules; and surrounding these, or following the line of the peribronchial lymphatics, are groups of miliary tubercles—thus proving their infective origin.

The principal features of catarrhal phthisis are the tendency to excavation and the comparative absence of fibrosis; and to these are due its less favourable course and more limited duration, compared with that of other chronic varieties, and especially the fibroid. Patients may remain with their lungs in a tolerably quiescent state for years; but when, from some fresh exciting cause, more tuberculisation or excavation is induced, there seems to be no limiting power, the lungs become rapidly disorganised, and the patient sinks.

Treatment.—This resolves itself into (1) treatment of the catarrh and (2) treatment of the after-lesions. During the catarrhal stage, the great point is to promote expectoration, and thus prevent aggregation of the epithelium in the alveoli and smaller bronchi; but here we are often met with a difficulty in the form of the badly developed chests and weak expiratory muscles of many of these patients, which renders expectoration difficult. The treatment should be that of bronchitis in a badly developed and ill-nourished patient: expectorants of various kinds, administered in a manner not likely to nauseate the stomach and interfere with the appetite, combined with friction of the thoracic walls by stimulating liniments. Some authorities go as far as to recommend emetics; but, unless there was risk of death from asphyxia, I should not recommend them, as they are only of temporary use, and would be pretty certain to derange the appetite. Carbonate of ammonia, senega, compound tincture of benzoin, all do good; but

what I have found most useful has been an effervescent potash draught with five grains of carbonate of ammonia, taken every four hours; because, while it promotes free expectoration and action from the kidneys, it does not upset the appetite. Stimulant inhalations, such as benzoin or iodine or the pinus sylvestris, are reported to do some good; and I have seen fair results from the use of ipecacuanha wine in the spray-apparatus, as advocated by Drs. Ringer and Murrell. Friction of the chest-wall with compound camphor liniment, or with linimentum terebinthinæ acetum, have also appeared to me to promote expectoration by stimulating the expiratory muscles. If, however, we entertain no doubt that consolidations have formed, we must trust more to general than local treatment, though attention must be paid to both. A generous dietary, including meat three times a day; abundance of milk, which, if taken warm, promotes expectoration; cod-liver oil, with dilute phosphoric acid and bitters; the local application of iodine over the affected side,—are the means most likely to prove effectual.

The climate most suited for these patients has been a matter of my most serious consideration; but a comparison of the results of the various climates in these cases has pointed to the conclusion that a warm moist air answers best. My statistics, as published in my recent Lettsomian Lectures (*Influence of Climate in Pulmonary Consumption*), show that at Madeira catarrhal phthisis fared better than on the Riviera, or in Egypt, or on sea-voyages; and it is probable that this is owing to the air of Madeira containing, combined with warmth, sufficient moisture to render expectoration easy.

ON CURRENT-MEASUREMENT IN ELECTROTHERAPEUTICS, AND IN THE ELECTROLYSIS OF BLOOD.*

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THE purport of this paper is to advocate a more definite method than the one usually adopted of estimating the dose of electricity administered to a patient. The dosage of electricity is generally recorded by a statement of the kind of battery and number of cells used; as I have elsewhere had occasion to point out, this method is necessarily fallacious. Different batteries have different electro-motive force; and the same battery, from variation in its resistance and from other causes, will evolve more current at one time than at another. A still more formidable obstacle to the estimation of the current-strength by the number of cells used is the variation in conductivity of the patient's skin; not only do different individuals offer different resistances, but the same individual may, on two occasions, vary in resistance to the extent of several thousand Ohms. This variation is principally due to the action of the sudoriparous glands; the drier the skin, the higher the resistance. Up to a certain point, the resistance of the skin diminishes during an application when the electrodes are stationary, the stimulating effects of the current promoting increased action of the sweat-glands.

The amount of electricity administered to a patient is the product of two factors—the electro-motive force of the battery and the total resistance; the formula, as expressed in Ohm's well-known law, is

$$C = \frac{E}{R}.$$

Now, even supposing the electro-motive force and internal

resistance to be constant in all batteries, and of known value, the enormously varying and unknown external resistance would prevent any accurate estimate of the strength of the current being deduced from this formula. By including a galvanometer in the circuit, the difficulty is overcome, the needle being deflected proportionately to the strength of the current; and if the galvanometer be graduated in fractions of the unit of current, the indications will be of absolute current-value. Along with Mr. J. T. Sprague, who possesses the patent right in this country for the graduation of galvanometers in degrees of current and resistance, I have devised an instrument which indicates, in ten-thousandths of a Weber (the British Association unit of current), the dose of electricity administered to a patient. The graduations of this galvanometer, representing actual current-values, are constant for all instruments similarly constructed, enabling the operator to record the dose administered, not relatively, but absolutely; thereby conveying a definite idea of the strength of the current, and placing it within the power of any one using such an instrument to administer an equivalent dose. This instrument possesses, I believe, an advantage peculiar to itself;

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the divisions, instead of following the law of tangents and becoming rapidly closer after the first ten or fifteen, by a peculiar arrangement of the coil and needle, are spread out in the portion of the scale most frequently used, adding considerably both to the ease and to the delicacy of observation.

It is obvious that current-measurement is necessary to develop the therapeutic use of electricity, the action of any remedy being only ascertained by accurate estimation of the dose administered. When the chemical action of the current is solely utilised, as in the treatment of aneurism by electrolysis, current-measurement becomes imperative. The want of definite knowledge on this subject induced me to investigate experimentally the formation of blood-clots by the voltaic current. The experiments were made with human blood and with that of the lower animals, to which various chemical reagents were added to retard or prevent natural coagulation. A few observations were taken with horses' blood, which retains its fluidity sufficiently long for experiments to be made without the addition of preventives to coagulation.

An apparatus was constructed so that two or more platinum or steel wires of equal diameter, placed at equal distance apart, could be immersed into the blood to a known depth. The current, measured by one of my galvanometers, was allowed to pass for a definite time, observations of the current-strength being taken every minute; the resistance ranged from 750 to 2260 Ohms. At the conclusion of each experiment, the clot formed on the anode was thoroughly drained on filtering-paper and accurately weighed. The observations of the current-strength, together with the weight of clot, were then reduced to a common mean, giving the weight of clot formed per minute by a current-strength equal to the one-hundredth of a Weber. The deposit round the cathode, being from more than coagulum, was not estimated. In some experiments, another apparatus was employed. A portion of the aorta of a cow, immediately after the death of the animal, was filled with blood and a needle connected to the anode inserted into it, the cathode being attached to a piece of tinfoil placed on the external surface of the artery.

The difference in the clots formed by relatively large and small currents was ascertained—(1) by taking the specific gravity of the clots in oil, and reducing the result to the usual standard—distilled water; (2) by re-weighing the clots when they were thoroughly dried; (3) by microscopic examination of the texture of the clots after washing them free from corpuscles; (4) by general observations of their consistence and tenacity.

In order to ascertain the effects of variations in the density of the current—that is, the proportion the current bears to the area of the electrodes—two depositing cells containing blood were set up "in series". In one cell, two wires were immersed five-tenths of an inch; in the other, similar wires were immersed only one-tenth of an inch; the current-strength passing through each cell being necessarily the same. The experiment was varied by substituting for the larger wires slips of platinum foil exposing an area of three-tenths of a square inch. The clots obtained were examined after the former manner.

Table showing the Mean Weight and Specific Gravity of Clot deposited per Minute by a Current-Strength equal to the one-hundredth of a Weber. Mean Temperature 69.5 deg. Fahr.

Metal forming Electrodes.	Weight of clot in grains.		Loss per cent. on drying.	Specific gravity.
	Recent.	Dry.		
Platinum.....	.1397	.0333	76.163	1.025
Steel.....	.1092	.0408	62.683	1.140

The conclusions drawn from a number of experiments conducted after the methods above indicated may be briefly epitomised. *The rate of clot-formation is in direct proportion to the current-strength.* With a complex fluid like blood, there is great difficulty in ascertaining this proportion with precision. Without great care, the means taken to keep the fibrin in solution introduce errors seriously affecting the results. *The specific gravity of electrolytic clots is inversely proportional to the strength and to the density of the current.* There is, however, practically little difference in the general character of the clot produced within the limits of current-strength usually employed in the treatment of aneurism.

Clots formed on platinum wires were found to be more bulky and of greater weight, but of less specific gravity, than those formed under like conditions on steel wires. The increase in bulk is due to porosity of the clot produced by the presence of free oxygen. When steel wires are used, the nascent oxygen combines with the iron. On reference to the table, it will be seen that clots deposited on steel needles after desiccation exceed in weight those deposited on platinum. The excess in weight is produced by oxidation of the anode, and by the consequent presence of oxide of iron in the clot.

With a weak or medium current, clots formed on steel wires are more friable than those formed on platinum. When the current-strength is great (.05 Weber), the deposit on steel wires is pasty. Platinum clots, when moist, bear a considerable amount of pressure without disintegration; steel clots, on the contrary, break up under moderate pressure; this difference exists in clots produced by medium currents. With the use of steel needles, the current-strength rapidly diminishes, owing to the oxide of iron formed on the anode setting up a counter electro-motive force, which opposes the battery-current; with platinum or thickly gilt steel needles, the polarisation is comparatively slight.

Clots deposited from blood at 60 deg. Fahr. are not so dense as those deposited at the normal temperature (98.4 deg. Fahr.), the rate of deposition being the same.

The practical conclusions to be deduced from these investigations, as regards the treatment of aneurism, are as follows. The current-strength should not exceed .015 Weber. A current-strength equal to .01 Weber produces a firm clot, and may be theoretically taken as the standard. Currents of lesser magnitude deposit equally good clots, but necessarily require longer time to produce a given result. It is advisable to introduce two or more needles, and to connect them alternately with the anode. With gilt needles, this alternation gives time for absorption of the nascent oxygen by the circulation; if ungilt steel needles be used, the polarisation is allowed to subside, and this otherwise seriously interferes with the action of the battery.

The insulation of the needles, so far as the portion outside the aneurism is concerned, should be as perfect as possible, not only to avoid the action of the current on the extra-aneurismal structures, but also to concentrate the current on the portion of the needle within the sac.

The propriety of introducing the cathode within the aneurismal sac, or of completing the circuit by a moistened electrode applied externally, resolves itself entirely into a question of resistance; for the deposition round the cathodal needle cannot be regarded as a clot, or as in any way aiding in the consolidation of the aneurism. If a sufficient current-strength can be obtained by the use of an external cathode, it is of no advantage to introduce it within the sac. At the same time, there is no objection to the use of an internal cathode, provided the shaft is well insulated; for it must be remembered that the caustic action of the current is chiefly confined to the cathode. The hydrogen liberated by an internal cathode has been proved by experience to be productive of no evil results.

The duration of an application must depend upon the current-strength, half an hour to an hour being usually sufficient. When not contra-indicated, it is well to allow the anodal needles to remain *in situ* half an hour after detachment of the battery, in order to permit of consolidation of the clots. The needles, especially those connected with the anode, should have a rotary motion imparted to them previously to withdrawal, in order as far as possible to avoid disturbance of the clots.

My investigations upon this subject not yet being complete, I hope on a future occasion to make known the results of further experiments.

A CASE OF ABDOMINAL ANEURISM BECOMING DIFFUSED AFTER DISTAL COMPRESSION.*

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THE patient from whom the specimens before you were obtained was a married man, aged 31, admitted into the Bristol General Hospital on November 2nd of last year. He was a clerk, a native of Bristol; had never indulged in any kind of violent exertion; never had gonorrhoea; careful inquiry elicited no suspicion of syphilis. Four years ago, he was ill for six weeks with rheumatic fever; he had suffered from no dyspnoea until lately. The present illness began about seven months before admission, with pain over the liver and tenderness on pressure. Soon afterwards, the patient had pain about the epigastrium, and a stoppage of the bowels for seven days occurred, which yielded to purgatives; the pain was then relieved. Similar pain then began to come occasionally on each side, about the umbilicus, or in the back, gnawing in character; two or three times, there were shooting pains down the right thigh. For the last fortnight especially, the epigastric pain had been worse after food, coming on almost directly after a meal,

* Read before the Bristol Medico-Chirurgical Society.